



THE UNIVERSITY *of* EDINBURGH

Edinburgh Research Explorer

Market devices and structural dependency

Citation for published version:

MacKenzie, D 2019, 'Market devices and structural dependency: The origins and development of 'dark pools'', *Finance and Society*, vol. 5, no. 1, pp. 1-19. <https://doi.org/10.2218/finsoc.v5i1.3015>

Digital Object Identifier (DOI):

[10.2218/finsoc.v5i1.3015](https://doi.org/10.2218/finsoc.v5i1.3015)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

Published In:

Finance and Society

Publisher Rights Statement:

Creative Commons License

This is an Open Access journal. All material is licensed under a CC BY-NC-ND 4.0 licence, unless otherwise stated. Please read our Open Access, Copyright and Permissions policies for more information.

General rights

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.





Market devices and structural dependency: The origins and development of ‘dark pools’

Donald MacKenzie

University of Edinburgh, UK

Abstract

‘Dark pools’ are private, electronic share-trading systems in which participants cannot see each other’s buy and sell orders. This article shows that the development of these material ‘market devices’ was strongly shaped by the structural dependency of their intended clientele (fund-management firms) on the big investment banks, particularly the indirectly monetary mechanism of dependency known in the US as ‘soft dollars’. The article’s underlying argument is that (a) the sociological analysis of financial markets requires bringing together the focus on materiality of, for example, actor-network theory with an emphasis on structural advantage such as that found in field theory; and (b) that both actor-network and field theory approaches could be strengthened by a stronger focus on mundane but important monetary mechanisms such as ‘soft dollars’.

Keywords

Dark pools, market devices, field theory, actor-network theory, social studies of finance

Introduction

The sociotechnical systems within which trading takes place are of enormous importance.¹ They influence what can be traded, by whom, with whom, with what consequences, and at what cost. Investors often do not or cannot trade financial instruments such as shares directly among themselves, but only via intermediaries. The fees intermediaries earn are an important component both of the stubbornly high costs of the financial system (Philippon, 2015) and, via high pay in that system, of inequality (see, e.g., Godechot, 2013). So what shapes trading’s sociotechnical systems? This article addresses this question by examining the development of ‘dark pools’, a particularly well-known, even notorious, type of trading venue, but one that has been almost completely neglected in the sociology of finance and related fields.²

Corresponding author:

Donald MacKenzie, School of Social and Political Science, University of Edinburgh, Chrystal Macmillan Building, Edinburgh, EH8 9LD, Scotland. Email: DonaldMacKenziePA@ed.ac.uk. <https://doi.org/10.2218/finsoc.v5i1.3015>

Dark pools are private, electronic share-trading systems via which subscribers can bid to buy shares or offer to sell them, without those bids or offers being visible to other traders, as they usually are on a registered stock exchange. The article traces the history of dark pools and considers the question of how best to theorise the development of these pools (and indeed of electronic trading venues more generally). It draws on the interviews and documents outlined below in the section on Data Sources, and is part of a much larger study (reported in part in MacKenzie, 2018) of automated trading, of the electronic trading venues on which it takes place, and of how trading both shapes and is shaped by those venues.

The most immediately attractive theoretical approach to the theorisation of trading venues such as dark pools is that of the actor-network economic sociology of Michel Callon, Fabian Muniesa and many others (see, e.g., Callon, 1998, 1999, 2007, 2017; Muniesa, 2003, 2007, 2011, 2014). As actor-network theory highlights, trading is not reducible to human action alone: it is a material process that is shaped strongly by non-human actants such as technologies, whether the latter are as simple as the octagonal, stepped amphitheatres of Chicago's traditional trading pits or as complex as the electronic infrastructures of today's markets. That shaping process is important, because both pre-electronic and electronic markets differ in consequential ways:

Algorithmic configurations calculate encounters [between supply and demand] differently ... each concrete market corresponds to a particular mode of organization (and calculation) of the connection between singular supplies and demands. (Callon and Muniesa, 2005: 1242)

Dark pools are thus examples of what actor-network economic sociology calls 'market devices': "material and discursive assemblages that intervene in the construction of markets" (Muniesa, Millo and Callon, 2007: 2). Indeed, they are devices in a directly material sense. None of the dark pools discussed here was or is operated manually: all were or are computer systems, with their single most important location in the US traditionally being NJ2, a computer data centre in Weehawken, just across the Hudson River from Manhattan.

The theoretical contribution of actor-network economic sociology is essential: any adequate analysis of today's trading needs to take account of the role played in it by material systems such as the servers packed into NJ2 and the huge, intricate web of cables, microwave, millimetre and laser links that interconnect servers and datacentres. Nevertheless, scholars from different traditions have criticised actor-network economic sociology sharply. Perhaps most outspoken was the attack by Philip Mirowski and Edward Nik-Khah on the actor-network thesis of the 'performativity' of economics as being potentially no more than "prettified neoliberalism decked out in new rags" (Mirowski and Nik-Khah, 2007: 217). However, their more general criticisms – neglect of the role of government and of "crude politics"; the need to bring back in "that despised entity Society" in place of actor-network theory's "flat ontology" (Mirowski and Nik-Khah, 2007: 200 and 216) – are shared by others such as the economic sociologist Neil Fligstein:

... network theorists and scholars interested in performativity have generally ignored the possible effects of government and law and the role of preexisting relationships between the owners of firms, managers, workers, and governments on market processes. This makes their accounts of particular markets incomplete. (Fligstein and Dauter, 2007: 107)

Issues such as those listed by Fligstein and Dauter are indeed prominent in the field-theoretic economic sociology developed by Fligstein (especially in Fligstein, 1996 and 2001) on the foundation laid by Pierre Bourdieu (in particular in Bourdieu, 1997). 'Fields' are meso-

level theorisations: less general than, say, a mode of production; more general than, for example, any particular economic transaction. A field is a specific, distinctive domain of social interaction, within which actors endowed with varying amounts of resources (not necessarily monetary) compete and/or cooperate to occupy favourable positions, either playing within the existing 'rules of the game' or seeking to alter those rules in their favour (Fligstein and McAdam, 2012; Kluttz and Fligstein, 2016).

Field theory's best known aspect is Bourdieu's famous classification of the forms of resources (especially economic, social, cultural and symbolic capital) that actors bring to bear in struggles within fields. But field theory can also take a more general form – laid out by Bourdieu (1997) and Fligstein (2001) – in which the actors are mainly organisations, not individuals. The focus, however, remains on how economic life is structured by relations of social power. Fligstein expresses the central argument with stark clarity: "The social structures of markets are ... fundamentally systems of power whereby incumbent (dominant) firms use tactics and strategies to stabilize themselves and reproduce their position over challenger (dominated) firms" (Fligstein, 2001: 69). That formulation, however, might suggest that the effects of power are always intentional, so perhaps there is reason to prefer a metaphor offered by Bourdieu (1997). A market, he argues, is not a homogeneous, 'Newtonian', space of atomistic interaction but a "field of forces", in which powerful firms and other organisations "deform space in their neighbourhood, giving it a certain structure", just as in Einstein's theory of general relativity a massive physical body 'warps' or 'bends' space, without of course intending so to do (Bourdieu, 1997: 52; my translation).

Relations between actor-network theory and field theory have often been hostile. The former developed in Paris in the 1980s and 1990s, at a time when Bourdieu was a dominant presence in French sociology. He reacted to actor-network theory with scorn, including a notorious *ad hominem* attack on Bruno Latour (Bourdieu, 2004: 26-31).³ Actor-network theorists in France have indeed hesitated to identify themselves as sociologists, often preferring the label 'anthropologist'. (With Lévi-Strauss's structuralism already in decline, French anthropology had no dominant incumbent equivalent to Bourdieu).

There is, nevertheless, perhaps something contingent about the antagonism between actor-network theory and field theory. Take, for example, the fundamental theoretical divide between the two: whether social relations exist. For Bourdieu and those who follow him it is axiomatic that they do, while for the actor-network theorist 'social' relations always constitutively involve non-human actants. As Latour puts it, the "'social' is not some glue that could fix everything ... it is *what* is glued together by many *other* types of connectors" (Latour, 2005: 5). Perhaps, though, this central divide between actor-network theory and field theory (and, indeed, most other conventional forms of sociological theory too) need not be construed as an *a priori* ontological matter, but rather – as Daniel Beunza and Yuval Millo suggested to me – as an empirical question. When the technology of trading changes, it is common for incumbents to seek to preserve existing 'social' relations and practices: to 'reincarnate' those relations and practices, so to speak, giving them new (silicon) flesh. Perhaps the clearest example is to be found not in the trading of shares but in bonds, where the incumbent dealers developed a form of electronic trading ('request for quotation' trading) that mimicked the existing practice of a fund manager telephoning a small number of dealers to request price quotations. As we shall see, though, the history of dark pools involves a similar effort by incumbents at 'reincarnation'. Do incumbents succeed? Can existing social relations be reincarnated? These are not *a priori* or ontological questions, but empirical ones.

Beyond whether social relations and practices can be preserved as technologies change, field theory suggests three ways in which existing investigations of market devices need

supplementing. First, there is a need to pay careful attention to systematic differences in organisations' positions in economic relations (differences that are sometimes focused on insufficiently strongly in the literature on market devices, such as some of this author's earlier work). Second, there is a need to identify the specific processes via which economic space is bent: the gravitational-field metaphor is vivid, but only a metaphor. Third, we need to examine the forces exerted not just by firms but also by government agencies. The article's penultimate section, for example, will briefly discuss the way in which recent European Union regulations may undermine the bending mechanism on which this article most closely focuses.

In its investigation of dark pools, this article builds on two existing bodies of literature. The first is studies of the transformation of exchanges from bounded physical spaces of face-to-face human encounters to electronic networks, of which the leading examples are Muniesa's study (2003) of the Paris Bourse and Pardo-Guerra's (2010) examination of the London Stock Exchange. The second is studies (such as Lange, 2016; Borch, 2016; Borch and Lange, 2017; Seyfert, 2016; and Coombs, 2016) of today's automated, ultra-fast 'high-frequency trading' (or HFT). Although the emergence of dark pools predates the rise of HFT, that rise – and accompanying fears of HFT – have strongly shaped the recent history of dark pools. What this article adds to the literature on HFT is, first, its investigation of features of markets that impinge on HFT practices (some dark pools for example, ban HFT entirely; others permit it, but police it, albeit sometimes not as rigorously as they have claimed) and, second, the article's suggestion that analyses of HFT need to take into account how the space of possibilities open to it is shaped by structural power.

To situate this article's empirical enquiry, let me briefly sketch the three differently-positioned categories of human/organisational actor central to the history of dark pools in both the US and Europe. The first – present in that history in an almost entirely passive role – is the legal owners of investment capital: pension funds, trusts, endowments, individuals and so on. The second is the fund-management firms that those owners employ to take the immediate decisions as to how and where to invest that capital. As is well known, an important aspect of financialisation has been the creation of a mode of corporate governance that influences – sometimes even forces – the managers of non-financial corporations to act in the interests of institutional investors (see, e.g., Useem, 1996). From the viewpoint of the history of dark pools, however, the above two categories of organisation – these two meanings of 'institutional investor' – need to be carefully distinguished. As we will see, the interests of fund-management firms and of the ultimate owners of investment capital are far from identical.

Furthermore, both these categories of organisation operate in a space that is bent by the mass of a third category of actor: broker-dealers, especially the biggest broker-dealers, the global investment banks. (A 'broker' is an intermediary who buys and sells on behalf of others; a 'broker-dealer' also trades on its own behalf.) Central banks such as the Federal Reserve aside, the global investment banks – such as Goldman Sachs, Morgan Stanley, J.P. Morgan, Deutsche Bank, Credit Suisse, BNP Paribas and Barclays – are arguably the single category of financial actor with the greatest institutional weight. In particular, while the above two categories of institutional investor occupy a powerful position with respect to non-financial corporations, this article suggests that they are often in a relationship of structural dependence to investment banks.

The article proceeds as follows. After this introduction comes a brief discussion of data sources, and then a section on the first generation of dark pools, which suggests that they can be seen as intended disintermediation devices: digital mechanisms by which fund managers could, at a low cost, trade directly with each other. They thus required fund managers to

disentangle themselves from their structural dependency on investment banks, but – as the article's fourth section documents – they failed to do so almost completely, thus remaining marginal to share trading.

These 'first-generation' dark pools were, however, succeeded by a second generation of pools set up by the investment banks themselves. The article's fifth section suggests that the new generation of investment-bank dark pools were an attempt at 'reincarnation', which involved turning the manual 'internalisation' by investment banks of fund managers' orders into electronic execution of them in a dark pool owned by the bank but authorised by the US stock market regulator, the Securities and Exchange Commission (or SEC). These second-generation dark pools were far more successful commercially than the first generation, but they too manifested a contradiction: to be successful, they required the participation of HFT firms. The pools' managers thus had to assuage fund managers' fears of HFT algorithms by reassuring them that they police those algorithms, for example electronically labelling algorithms that are too successful in making short-term profits as 'aggressive' or 'predatory', and giving their fund-manager clients the option of not interacting with algorithms deemed predatory (that characterisation of profit-making, by investment banks at the heart of financial capitalism, is striking). The article's penultimate section discusses recent European Union reforms that may have the effect of undermining the structural dependency of fund-management firms on investment banks. The final section is the conclusion.

Data sources

The research reported here is part of a much larger study of the emergence and current practices of high-frequency trading and the development of the markets in which it is practised. That study has involved extensive interviewing by the author of traders, broker-dealers, fund-management firms' traders, trading-venue staff, etc. (see table 1 below). Particularly drawn on here are seven of the study's 81 interviews with trading-venue staff. Those seven interviewees (EC, EH, EI, EJ, EW, EX and EY) were all employed by firms that manage dark pools and had extensive experience of running – and in some cases, setting up – those pools, but since this subsample is clearly small (and basing a historical account on interviewees' oral-history recollections alone would be unwise) I have therefore 'triangulated' the interviews with managers of dark pools against interview testimony from others such as those who trade in dark pools (for example on behalf of fund-management or HFT firms) and also against documentary sources.

By the late 1980s (the start of the period I examine), the new discipline of financial economics was in full swing, and its literature contains what are now historical data, for example on the typical sizes of broker-dealers' commissions. Particularly useful is a survey conducted in 1994 of 150 personnel at US fund-management firms who traded shares on behalf of those firms. The firms for which respondents worked managed shares worth around \$1.5 trillion, about half of what was then the total shareholdings of US fund-management firms (Economides and Schwartz, 1994: 31). The survey is now crucial historical evidence: it throws light on the reception of the first-generation dark pools by their intended clientele at fund-management firms. Beyond these published documents, I also draw upon relevant unpublished documents in the records of one of the earliest high-frequency trading firms, Automated Trading Desk (to which I was kindly given access by interviewees BE and BT).

Table 1. List of interviewees.

High-frequency traders (AA-CX)	75
Exchange and trading-venue members and staff (EA-HC)	81
Dealers, brokers, and broker-dealers (XA-YD)	30
Traders for investment-management firms (IA-IJ)	10
Practitioners of other forms of algorithmic trading (OA-OV)	22
Manual traders (MA-MK)	11
Suppliers of technology/communications links to HFT (TA-UC)	29
Researchers/market analysts (VA-VT)	20
Regulators, lawyers, lobbyists, politicians (RA-SB)	28
Total	306

A market device to end structural dependency? The origins of dark pools

What are now regarded as the first dark pools were set up in the US in 1986-7. To understand why, it is helpful to briefly review how US shares were traded in the 1980s. The dominant trading venue was the NYSE, the New York Stock Exchange, located in the heart of Manhattan's financial district. Fund-management firms could not trade directly on the NYSE: its rules laid down that they could trade only via a member of the NYSE, and fund managers could not readily become members. Using a member was expensive. The NYSE origins were in the 1792 Buttonwood Agreement, in which 24 brokers negotiated what turned out to be a durable private rule: not to charge commissions of less than 0.25 percent of the value of transactions.⁴

After pressure from Congress and the SEC, the NYSE's fixed commission rules were abolished in 1975. Commissions remained substantial, however, averaging 0.18 percent – nearly 7 cents per share for an averagely-priced NYSE stock – in 1985 (Berkowitz, Logue, and Noser, 1988: 104), and from around 4 cents to as much as 15 cents per share in the early 1990s (Keim and Madhavan, 1998: 51). Nor was trading on the main alternative to NYSE, Nasdaq (the National Association of Securities Dealers' Automated Quotation system), necessarily any cheaper. Nasdaq had no trading floor – its broker-dealers circulated price quotations electronically and traded primarily over the telephone – but a private rule tacitly agreed among those broker-dealers kept the typical minimum difference between the prices at which they would buy and sell shares to 25 cents per share.⁵

As we shall see shortly, fund managers were happier to pay high commissions than might be imagined. There was, however, also distrust: “many institutions ... felt they got screwed”, said interviewee BE. Fund managers' central fear was that investment banks and other broker-dealers took advantage of their knowledge of what fund managers were trying to do. In the

1994 survey referred to above, 37 percent of the sample of fund-management firms' traders cited fears of being front-run (an agent such as a broker-dealer profiting by trading on its own behalf before executing one's order) as the most important or second most important factor leading them to want to execute their trades quickly (Economides and Schwartz, 1994: 15).

From the 1970s onwards, however, a new set of market devices started to become available to fund managers, devices that offered them the possibility of in effect trading directly with each other at a cost much lower than that of using traditional intermediaries such as broker-dealers and the NYSE or Nasdaq. The first of these was the Institutional Networks Corporation's electronic 'Instinet' trading system, set up in 1969. A fund-management firm that subscribed to Instinet could enter bids to buy shares or offers to sell them via terminals linked to Instinet's central computer system. The bids and offers that could not be executed immediately were entered into an anonymous, aggregate order book visible to all subscribers on their terminals' screens.

Because the order book was visible, the original Instinet system was not a dark pool, but what would now be called a 'lit' market. That visibility, however, had the disadvantage of likely 'market impact': a big, visible buy order, for example, would typically push prices up, even though it was anonymous and could be seen only by other Instinet subscribers. In 1986, however, Instinet launched a market device that is now seen as the first 'dark pool', its new Crossing Network, which it described, in a document preserved among the records of Automated Trading Desk, as "an equities [i.e. shares] trading service that eliminates market impact" (Instinet, 1989: 1). After the NYSE had closed, fund managers could use the Crossing Network to submit anonymous, electronic bids to buy a corporation's shares or offers to sell them. These bids and offers were not displayed to other subscribers. Users simply entered, via their Instinet terminals, the number of shares they wished to buy or sell: the price was always that day's closing price of the shares at the end of public trading. At around 5.00 pm New York time, Instinet's computer system would 'cross' those orders, matching as many bids and offers as possible. Instinet charged a firm whose orders were successfully crossed in this way only one cent per share traded (Blume, 1993: 39), far less than the four cents or more that they would have had to pay an investment bank or other broker-dealer. A similar attractively priced, anonymous, electronic 'crossing' service for fund-management firms called Posit (the 'Portfolio System for Institutional Trading') was launched in 1987 by the Investment Technology Group. Like Instinet's Crossing Service, Posit's four daily 'crosses' also matched buy and sell orders at the price at which shares were trading on the public markets, in its case at a randomly chosen moment during the seven-minute interval in which users could enter orders into its system.

The Instinet Crossing Network and Posit were relatively simple systems, but in 2001 a new first-generation dark pool, Liquidnet, was launched. It is a far more sophisticated market device. Its key proponent, Seth Merrin, had pioneered electronic order management systems for fund managers, which cut out their need to use the telephone to transmit orders. Crucially, Liquidnet enjoyed, and still enjoys, continuous electronic access to the digital 'blotters' of fund managers' order management systems: the lists of the orders for shares that have not yet been executed. "[B]ecause [Merrin] invented [order management systems], he had recognition and credibility with the institutional investors", said interviewee EI, and Merrin was thus able to negotiate his system's access to the highly sensitive contents of blotters.

Whenever Liquidnet's system discovers that one fund manager's blotter contains an order to buy Apple shares, for instance, and another's blotter an order to sell them, it invites the two managers or their traders to begin an anonymous, tightly rule-governed, computerised negotiation over the price. A window opens on each of the two traders' computer screens, with a range of possible prices. If, using these windows, the two traders reach agreement over the

price, Liquidnet's system tells them how many shares they have bought and sold (that number – which the traders cannot negotiate over – is simply the smaller of the sizes of transaction each trader was seeking). An informal private rule restricts haggling over price: “most veterans that have been on the system for a while don't even negotiate, they just offer the mid [the midpoint of the range of prices in the window]”, and typically that is accepted straight away, reported interviewee EI.

Soft dollars and structural dependency: A ‘bent’ economic space

As noted above, Instinet's Crossing Network offered its fund-manager users the opportunity to trade for a cent per share, and other first-generation dark pools also sharply undercut the commissions of around 4-15 cents per share charged by investment banks and other broker-dealers. Yet these new, cheap, anonymous, market devices with their simple rules were adopted far less widely than one might have expected, and were far less successful in ending fund managers' structural dependency on investment banks. While a third of the traders for fund-management firms surveyed in 1994 had tried Instinet's Crossing Network or Posit, only 5 per cent had gone on to become frequent users (Economides and Schwartz, 1994: 24, table 20). Nor has that situation subsequently changed radically: see table 2 below. First-generation dark pools remain relatively marginal to US share trading. Why?

The 1994 survey asked fund-management firm respondents what would get them to use first-generation dark pools more often. The most common answer (given by 55 percent of respondents) was if “they gave higher execution rates” (Economides and Schwartz, 1994: 29, table 25). A frequent experience, in other words, was that sometimes you just could not find someone who wanted to buy when you wanted to sell, or vice versa. There was, though, a certain circularity to this first barrier to the adoption of dark pools. Electronic trading manifests network effects akin to those of telephone systems: the more users a trading system has, the easier it is to find someone with whom to trade.

A number of factors, though, made it harder for first-generation dark pools to attract enough users to become real rivals to trading via an investment bank or other broker-dealer. The most intriguing barrier was ‘soft dollars’: that was the second most commonly cited barrier among Economides and Schwartz's respondents. Soft-dollar arrangements had first emerged as US fund management grew in scale in the 1950s (Blume, 1993). Because fund managers' orders for shares were much larger than those of most individual investors, they were attractive customers for investment banks and other broker-dealers. The rules of the NYSE, however, prevented these firms competing for business from fund managers by offering discounted commissions on large trades. Accordingly, they began to provide fund managers with research reports, other free services, and direct payments, including, for example, expenses for trips to Europe with only a tangential research rationale. By 1983, these ‘soft-dollar’ arrangements totalled around \$600 million annually (Smith, 1984). Broker-dealers thus handed back to fund-management firms – sometimes as monetary payments, but mostly as ‘free’ services – part of the high commissions the firms paid them.

The reason why the dollars – or pounds, or euros – involved were, and sometimes still are, ‘soft’, from the viewpoint of a fund-management firm, was (and is) that commissions and other trading costs are charged to the pension or mutual fund whose capital is being managed, while if research, computers or hotel bills had to be paid for explicitly it would have to be by using the fund-management firm's ‘hard dollars’ (i.e., its own money). Of course, the higher the commissions paid out of the stock market funds a firm manages, the poorer the performance of those funds. However, the effects of high commissions do not stand out

among the inherently large fluctuations in the returns from portfolios of shares, while soft-dollar arrangements directly and substantially increase the profits of fund-management firms by eliminating costs (especially payments for research) they would otherwise have incurred. Although the term ‘soft dollars’ is obviously American, similar arrangements (sometimes called ‘soft commissions’ in the UK, or in France simply ‘softing’)⁶ have been prevalent in Europe too until recently: see the penultimate section of this article for the recent change.

Soft-dollar arrangements survived the 1975 abolition of their original motivation, the NYSE’s rules setting minimum commission rates. What Blume (1993: 36) calls “the soft-dollar industry” successfully sought from Congress a ‘safe harbor’ rule – Section 28(e) of the Securities Exchange Act, added in 1975 – legally protecting the practice. In the early 2000s, more than 70 percent of US fund-management firms still had soft-dollar relationships (Schwartz and Steil, 2002: 41). Although modified and increasingly constrained since then, soft dollars remained, and still remain, important to the economics of fund management in the US.

If fund managers traded via one of the first-generation dark pools, they did not earn ‘soft-dollar’ credit with an investment bank. At least one electronic trading system sought to compensate for this by charging the firms who traded on its system more than the cost of that trading, then remitting the excess to them as a direct payment.⁷ The arrangement may appear bizarre, but it replicated the way in which soft dollars benefitted a fund management firm, but not necessarily the investment funds it managed. It was, however, only a partial replica: while soft dollars were arguably the core of fund managers’ structural dependency on investment banks, they were not its entirety. An investment bank did not – and does not – simply provide its fund-manager clients with ‘free’ research reports. During most of this period discussed here, the leading investment banks such as Goldman Sachs enjoyed high prestige (high ‘symbolic capital’ in Bourdieu’s terminology), making links to them seem valuable to fund-management firms, which were generally less prestigious organisations. Individual fund managers and the investment bank ‘sales traders’ who catered to their needs were in frequent contact and often became friends. Investment banks also provided, as an integral ‘free’ part of the service they gave fund managers, access to executives of corporations in which the fund managers had (or were considering) investments, and the chance to participate lucratively in initial offerings (IPOs) of stock, along with, for example, ‘market colour’ (information on trading patterns). As interviewee TO put it:

Within a [fund-management] institution, for the most part, the portfolio manager is king; the trader is the low man in the organisation. And so the portfolio manager says: ‘look, if I get the right research, or if I get the right [market] colour on a stock, or the right access to [corporate] management ... IPOs, whatever, that makes a huge difference in my performance and a few basis points [hundredths of a percentage point extra costs] on the execution is all rounding error’. So I’ll trade with people [e.g. investment banks] who give me bad execution because I’m getting other things from them.

“We always used soft dollars. We still use soft dollars”, said interviewee IB, who works for a medium-sized fund-management firm: “it would be hard to stay in business if we didn’t use them. [Y]ou’d put a lot of these smaller [fund-management] companies out of business if they couldn’t use soft dollars”.

To invoke Bourdieu’s Einsteinian metaphor, then, first-generation dark pools had – and have – to operate in an economic space ‘bent’ by the gravitational pull exerted by the investment banks. For all their cheapness, and, in the case of Liquidnet, sophisticated design, first-generation pools struggled against what seems to have been a pervasive sense among fund managers that using an investment bank for one’s trading, though expensive, earned

tangible and intangible benefits, benefits that would be lost if one used a first-generation dark pool. If you did the latter, said interviewee ID, “you couldn’t get credit [with an investment bank]. The feeling was, this is business that I’m throwing out the window or dropping in a black hole because I get no relationship value from it”.

Preserving structural dependency: Investment-bank dark pools

During the 1990s, though, several new ‘lit’ electronic markets emerged to challenge first Nasdaq and then the NYSE, and in response those latter markets also began to turn towards fully electronic trading. Investment banks could not entirely stand aside from these developments. Alongside execution of orders by human traders, investment banks started also to offer fund managers somewhat less expensive algorithmic execution, for example via Credit Suisse’s Advanced Execution Services department, set up in 2001. Using Credit Suisse’s algorithms did not demand any technical knowledge. A fund-management firm’s trader could select the shares to be traded, “just type in ‘buy 100,000’ ... and it all gets worked on by the computer behind the scenes. You don’t need to be a programmer” (interviewee EH).

One way in which an investment bank could use those ‘execution algorithms’ was to break up fund managers’ large orders to buy or sell shares into smaller portions – ‘child orders’, as they are called – and send them out to the NYSE, Nasdaq or one of the new electronic venues. By doing so, however, the investment bank would incur fees that would cut into the revenue earned by executing fund managers’ orders. Investment banks therefore preferred if possible to ‘internalise’ those orders, for example buying shares from one fund manager and then selling them to another, without the use of external markets. Although ‘internalisation’ thus offered an investment bank cost savings, it was only very loosely regulated and had “a nasty connotation in the US, because there was always a lot of gamesmanship ... ‘did I get a fair price?’, ‘did I not get a fair price?’” (interviewee EX). In 2005, furthermore, the Securities and Exchange Commission’s Reg NMS (Regulation National Market System) increased the complexity of internalisation by laying down that it could be conducted only at a price no worse than the constantly fluctuating best prices on the registered exchanges.

A second generation of dark pools thus emerged as attempts to keep the economic benefits to investment banks of internalisation, while increasing the latter’s legitimacy, and more generally ‘reincarnating’ – giving new technological form to – the structural dependency of fund managers on investment banks. Instead of having human traders (often with close personal relationships to their fund-manager clients) internalise orders, investment banks turned the internal, manual matching of orders into automated dark pools registered under the SEC’s 1998 Regulation ATS (Alternative Trading Systems), the regulatory framework that enables private actors to set up trading venues that are not registered exchanges. That regulation’s goal (my interviews with regulators suggest) was to encourage new ‘lit’ electronic markets to compete with the traditional exchanges by simplifying the process of registering them, but it had the unintended effect of making it easier to create and register dark pools. As interviewee EX, who was heavily involved in the establishment of the new investment-bank dark pools, put it: “we could create ... a proper execution venue with a blessing of the SEC, and all of a sudden it wasn’t internalisation anymore, it was crossing, right? It’s identical process, identical flows; everything was the same except we had a machine do it instead of having people do it.” Existing social relations and practices were indeed therefore preserved in a new technological form.

The rules of the earliest of the first-generation dark pools did not allow users to specify the prices at which they wanted to buy or sell. Instead, the pools automatically matched buy and sell orders at the midpoint of the price range prevailing on exchanges such as the NYSE (as noted above, this was in practice what usually happened even on Liquidnet). Second-generation US dark pools more closely mimicked electronic exchanges: although orders are in practice often simply matched at the midpoint, users can, for example, specify a maximum price at which they will buy shares, and an order of this kind will be executed by the pool's computer system only if there is a sell order at a corresponding price. However, unlike on a 'lit' market, orders that have not yet been executed are not visible to the traders and computerised trading systems using the dark pool.

The gravitational pull of the investment banks remains such that many fund managers continue to use them for much of their trading. The commissions that fund-management firms therefore continue to pay to investment banks enable those firms to fulfil their 'soft-dollar' obligations and thus receive 'free' research and other services. My interviews suggest that fund-management firms quite often use their own execution algorithms, or algorithms written by third parties, to split big orders into large numbers of child orders, but they often then simply send those orders to investment banks for execution. It is normally then the investment bank's systems, not the fund manager, that decide where those orders should be routed. Interviewees reported that, unsurprisingly, a bank's systems' first choice would often be its own dark pool. Only if a child order could not be executed there would it then be sent on to other banks' dark pools and perhaps eventually to public 'lit' markets.

Table 2. Approximate average daily transaction volumes on leading US dark pools (September 2009).
Sources: MacKenzie and Thomas (2009); Angel, Harris, and Spatt (2013).

Name of dark pool	Millions of shares	% US share trading
Credit Suisse Crossfinder	155	2.2%
Knight Link	128	1.8%
Goldman Sachs Sigma X	112	1.6%
Getco Execution Services	90	1.3%
Level	52	0.7%
Citi Match	44	0.6%
MS-Pool	36	0.5%
UBS PIN	32	0.5%
Liquidnet	28	0.4%
Barclays LX	24	0.3%
ITG Posit	22	0.3%
Instinet CBX	21	0.3%

Second-generation dark pools were thus consistent with the structural dependency of fund-management firms on investment banks. It was a recipe that generated substantially larger volumes of trading than on the first-generation pools. By September 2009, for example, Credit Suisse's Crossfinder dark pool was trading an average of around 155 million shares a day, and Goldman Sachs's Sigma X about 112 million, compared to around 28 million traded on Liquidnet, the highest-volume first-generation pool (see table 2). Dark pools as a whole gained market share. In 2008, only just over 4 percent of share trading in the US was in dark pools (Angel et al., 2013: 29, table 2.19). By December 2014, that had climbed to 17 percent (D'Antona, 2014).

Policing dark pools

How, though, was an investment bank to boost the probability of what was for it usually the economically optimal outcome: a fund-manager client's 'child orders' being executed in the bank's own dark pool? While first-generation dark pools typically continue to exclude HFT firms and other proprietary traders, the investment-bank owners of second-generation pools have seen benefits in allowing them to participate. HFT, as already noted, is automated and ultra-fast, and it usually involves very large numbers of individually small purchases and sales. HFT algorithms are thus the perfect match for the streams of electronic 'child' orders flowing from an investment bank's fund-manager clients into the bank's dark pool. This, though, has meant that second-generation dark pools have to contend with a pervasive fear among fund managers: that HFT firms' algorithms are profiting at the expense of their orders to buy or sell shares. As *Traders Magazine* noted, there was and is "concern on the buy side [fund-management firms] that trades done in dark pools can result in information leakage that worsens the final price at which they trade" (Chapman, 2012: n.p.). That makes some pools 'toxic', as interviewee AE put it. Asked what he meant, he replied: "I mean that there's high-frequency trading dudes in there".

Simply excluding high-frequency trading algorithms is not, however, an attractive option for the investment banks that manage second-generation dark pools, because of the vital role those algorithms play in increasing the chance that a fund manager's order will be executed in the bank's own dark pool. The investment-bank dark pools have sought instead to monitor and categorise the behaviour of the HFT and other algorithms trading in the pools. A leading figure in Barclays' LX dark pool told *Traders Magazine*: "We want our clients to know we really understand what is going on inside LX and that we are watching on their behalf" (Chapman, 2012: n.p.). As the magazine put it:

By using a sophisticated new surveillance system, Barclays is able to evaluate the trading practices of the participants in its pool and create precise profiles of those traders. Armed with that information, it can confront the bad actors and ask them to change their behavior. If they don't, they may be asked to stop trading in the pool. (Chapman, 2012: n.p.)

How the surveillance system at Barclays worked is in the public domain because of the lawsuit referred to below, so let me focus on that pool. (The systems employed in the other pools seem broadly similar). The system, called 'Liquidity Profiling', was launched in 2011, with (as the bank put it) the goal of distinguishing between "beneficial liquidity that should be accessed by all clients" and more "'aggressive' order flow" (Barclays' 2011 marketing materials, quoted in Barclays, 2014: 8). The system classified the trading of HFT firms and other users of the pool on two dimensions. The first was "one-second take alpha", which

involved automated calculation of the average change in the price of a stock in the second after a firm's human traders or algorithms had 'taken liquidity': that is, had consummated a trade by sending in a buy order that was matched against an existing sell order in the invisible order book (or a sell order that was matched against an existing bid to buy). 'Alpha' is a common financial-market term for profit.⁸ Here, a positive value of 'alpha' implied that prices tend to change in a firm's favour immediately after its liquidity-taking trades: "This could indicate that the trader is trying to benefit from short-term price changes" (Barclays, 2014: 9). The second dimension on which participants in Barclays' dark pool were algorithmically ranked was the average size of their orders (relative to others' orders for the same stock). "[S]mall orders", said Barclays (2014: 9), "may be an indication that the trader is using an aggressive trading strategy". An example would be 'pinging the book': repeatedly sending in very small orders in the hope of detecting large orders that had not yet been filled.

Drawing upon its automated measurements of firms' alphas and order sizes, Barclays assigned participants in its dark pool a score from 0 to 5. A score of '4' or '5' indicated the "safest, most passive, long-term investor-like trading activity", while "neutral traders were rated '2' or '3'" (Barclays, 2014: 9). A score of '0' or '1' indicated the "most aggressive, predatory trading activity" (Barclays, 2014: 9). (In other places, Barclays described such activity as "very toxic" [Barclays' analysis of 16 January 2014, quoted by Schneiderman, 2014: 18]). Those who used Barclays' dark pool were given the option of never having their orders interact with those of participants in this electronically stigmatised category.

As noted above, other second-generation investment-bank dark pools employ similar surveillance and categorisation schemes. It would, however, be naïve to take such classifications as simple moral impulses. Only two of the seven interviewees whose trading venues engaged in surveillance and classification of this kind said they viewed them as moral in nature. The view that "this is business", as one of them put it, was more common, and other motivations for surveillance and classification that were cited by interviewees were simply that "clients do want it"; that it was important to be able to demonstrate that when traders employed by the investment bank or other owners of a dark pool traded in it – which, at least until recently, was not uncommon – their trading was benign; and that in a situation in which dark pools were being heavily criticised by the leaders of 'lit' markets such as the NYSE, it was vital to be able to show regulators that behaviour in dark pools is under "full control".

There is, furthermore, evidence that this private regulation of algorithmic behaviour in dark pools was not always rigorous, with, for example, automated 'aggression' scores sometimes being overridden manually by managers. That evidence was collected by an investigation by the Attorney General of New York State, Eric Schneiderman, later joined by the SEC. In 2016, two of the world's largest investment banks, Barclays and Credit Suisse, agreed to pay a total of over \$150 million in penalties to settle allegations that they had not policed their pools in as rigorous a way as they had advertised to their fund-manager clients. In 2018, a third major bank, Citigroup, agreed to pay \$11.9 million to settle charges that included allegedly misleading clients as to whether HFT was allowed in its 'premium' dark pool, Citi Match.

The European experiment

The revelation that investment banks were not always policing their dark pools in the way they had promised their fund-manager clients provoked real anger among some of the latter (expressed, for example, by interviewee IG), contributing to a further loss of investment banks' symbolic capital, already damaged by their role in the global financial crisis. In addition, the

economic capital of the biggest US fund-management companies has grown fast, and some have started disentangling themselves from soft-dollar arrangements, paying directly for research in return for lower trading fees. These developments, though, have not yet been sufficient to displace investment banks from their central role in the US financial system. Second-generation investment-bank dark pools continue to operate in broadly similar ways, embedded in similar patterns of relations between those banks and fund-management firms – although with forms of policing that are now likely to be more rigorous than before the law suits.

In Europe, though, what is in effect a more thorough-going experiment in the matters discussed in this article has begun. Both generations of dark pools spread fairly quickly from the US to Europe. However, while European regulators have generally welcomed first-generation pools (with their goal of facilitating large, low cost, low market impact trades between fund managers), they have been more sceptical of the virtues of second-generation, investment-bank-owned pools than their US counterparts. The European Union's new financial regulations, MiFID (Market in Financial Instruments Directive) II, in force since the start of 2018, limit to 8 percent the proportion of the trading of any stock that can be conducted in pools of the second-generation kind, dominated by high volumes of small algorithmic trades. The goal of regulators has been to ensure that as much trading as possible takes place in 'lit' venues – especially registered stock exchanges – or, failing that, in large-scale deals in dark pools of the first-generation variety.

It is as yet unclear whether MiFID II will achieve the desired return of trading to 'lit' markets. However, MiFID II's explicit dark-pool regulations may turn out to be less significant than its attack on the European equivalents of 'soft dollars'. MiFID II requires fund managers in the European Union to pay explicitly for research, access to corporate executives, and so on. They can still pass on investment banks' charges for these services to the funds whose capital they manage, but MiFID II requires them to do this openly and in detail. Will this measure reduce the structural dependency of fund managers on investment banks? It is too early to tell, but there is a chance it will, and, for example, interviewee EZ reports that the European first-generation dark pool he used to be involved with has enjoyed a marked increase in business since MiFID II came into force.

Conclusion

Actor-network theory's contribution to economic sociology is, to repeat, essential. It prompts us, for example, to 'open the black box' of technical systems such as dark pools. If confronted with actors with different technical capacities, it does not simply invoke differences in "capital technologique" (Bourdieu, 1997: 52), but pushes us to enquire in depth into both what those different capacities are and also their consequences. There does, however, remain a risk that enquiries of this kind can underplay both issues of structural dependency and Fligstein and Dauter's "effects of government and law" (Fligstein and Dauter, 2007: 107). The brief section on Europe that precedes this conclusion highlights exactly one of these latter effects. The European Union's regulatory initiative may not ultimately bear fruit, but attention surely needs to be paid to it because – in its attack on one of the foundations of fund managers' structural dependency on investment banks – it can be seen as a conscious attempt to alter the bending of economic space. Field theory has, in addition, other benefits that have not been focused on here, such as its reminder to pay attention to cultural capital, which continues to play important roles in finance. Anglophone readers, confronted by stark evidence of, for example, the continuing huge importance in the French financial sector of a degree from one of the

grandes écoles (Bourgeron, forthcoming; Godechot 2000), can succumb to the assumption that this is 'a French thing', but I suspect that it is simply that exotic examples of cultural capital such as this are easier to see than its mundane operations in more familiar settings.

Incompatibilities between actor-network theory and field theory of course remain, as even the small minority of scholars of social theory who have sought to promote dialogue between the two traditions are forced to admit (see, especially, Bénatouïl, 1999, but also Schinkel, 2007). At root, the actor-network critique, quoted above, of the implicit assumption in much sociological thinking of 'the social' as some kind of pervasive 'glue' is surely correct: the diverse 'connectors' that constitute 'the social' indeed need investigating without prejudging the nature of those connectors. Perhaps, though, the classic actor-network investigations of connectors underplayed the role of the very important connections that flow in and between those most familiar of material entities, human bodies. True, that neglect of the human body was addressed in later actor-network theory, particularly by Mol (2002), but it remains the case that Bourdieu sensitises us more directly to issues of bodily habitus and bodily appearance: again, the loosely Bourdieusian study by Bourgeron (forthcoming) is exemplary in its attention to the role of the body in the apparently abstract practices of private equity funds.

This article does not argue that Latour (or Callon) and Bourdieu can simply be hybridised, for plainly they cannot. The argument, rather, is that the sociology of finance requires the best empirical sensitivities of both: the actor-network focus on the role of devices in social life, and the Bourdieusian focus on structural advantage. If actor-network theory and Bourdieu's 'critical sociology' are thought of not as ontological but as empirical, then some of the stark incompatibilities between the two soften (as Bénatouïl, 1999, suggests, albeit at a more abstract level). To some extent at least, the empirical findings of one approach can actually be translated into the theoretical framework of the other. For example, this article has emphasised 'soft dollars' as the core of the Bourdieusian structural dependence of investment-management firms on investment banks, but soft dollars are of course an actor-network market device. 'Soft' they may be, but the underlying flows of money (or expenditure that is avoided) are noticed on both sides of the relationship, and, as time has gone on, increasingly measured and accounted for by both fund managers and investment banks.

'Soft dollars', though, also point to an empirical weakness in much of the economic sociology of both sides of the theoretical divide on which I have focused, which is insufficient attention to flows of money and the way those flows condition and shape finance's organisations and technical systems – with, on the broadly Bourdieusian side, the important exception of Godechot (2007). What was novel in actor-network economic sociology was, as I have emphasised, the focus on market devices; what was novel in Bourdieu was a sociology of culture of unprecedented sophistication and rigour. Both insights are vital, but it is important (especially for scholars such as this author who come to economic sociology from the sociology of science and technology) not to neglect what is ultimately the most pervasive aspect of the financial system: that money flows through it, that a non-trivial proportion of that money is captured by financial intermediaries, and that the exigencies of that capture (and, sometimes, struggles over it) shape the financial system profoundly. That capture by intermediaries is, for example, most likely the core explanation for Philippon's shocking (2015) finding that the efficiency of the US financial system – the unit cost of financial intermediation – shows no clear tendency to improvement from the 1880s to 2012. Capture of flows of money by intermediaries is also plainly at the heart of the substantial contributions that high pay and bonuses in the financial system make to growing inequalities of income and wealth.

A new tradition of sociological enquiry into finance seems to be emerging in France, one that focuses on flows on money while still maintaining – in exactly the way this article

advocates – both the actor-network focus on market devices and the Bourdieusian focus on structural advantage. The best single example so far of this new work is Benquet (2018), which is a study of the private-equity sector in France based on extensive fieldwork. There is a market device at the core of that sector, a form of accounting that Benquet documents at the detailed level of the best actor-network studies. However, she also focuses on how that form of accounting is shaped by the needs of, and facilitates, high remuneration of – flows of money to – all the central parties in private-equity buyouts. Our field has learned from French scholarship in the past: decisively so from actor-network theory, less so (but in some cases still substantially) from Bourdieu. Perhaps it is time to learn again, but the lessons to be learned this time are going to be subtly different. Market devices such as dark pools matter, as does structural advantage, but understanding both requires attention to how money flows and is captured. The story of dark pools – of their shaping by structural dependency, and of the role in that dependency of ‘soft dollars’ – has its idiosyncrasies, but, I would argue, is in this sense typical.

Acknowledgments

The research reported here was supported by the UK Economic and Social Research Council, under grant ES/R003173/1; and by the European Research Council, under grant 291733. The argument of this article was briefly sketched in the opening plenary of the 2018 conference of the Finance and Society Network. To illustrate that argument, the article’s empirical sections draw upon two earlier pieces (MacKenzie, 2015, and Arjaliès, Grant, Hardie, MacKenzie and Svetlova, 2017) supported by the European Research Council grant. Discussion with Daniel Beunza and Yuval Millo was particularly helpful in pointing my attention to the importance of attempts to preserve existing social relations and practices in new technological form, and I am very grateful to *Finance and Society*’s editors and referees for insightful comments on the first draft of this article.

Notes

1. As noted in the acknowledgments, the empirical sections of this article draw upon an earlier article on dark pools by the author in the London Review of Books (MacKenzie, 2015) and chapter 5, drafted originally by him, of Arjaliès et al. (2017).
2. As far as I am aware, the only extended discussions of dark pools in that literature are the article and chapter cited in the previous note.
3. “[T]hese people, who often refuse the name and the contract of sociologists without really being able to submit to the constraints of philosophical rigour, may enjoy some success among new entrants...” (Bourdieu, 2004: 31).
4. A facsimile of the Buttonwood Agreement manuscript is available at: http://en.wikipedia.org/wiki/Buttonwood_Agreement. Accessed 18 April 2015.
5. Until the mid-1990s, US shares were priced in the traditional eighths of a dollar. The rule was not to quote prices in odd eighths, so keeping the minimum difference between the prices at which broker-dealers would buy shares and sell them to two eighths of a dollar, or 25 cents. See Christie and Schultz (1994).
6. Marc Lenglet and Olivier Godechot, personal communications.
7. This arrangement is revealed by a document in Automated Trading Desk’s records (Whitcomb, 1989). ATD, however, did not benefit: the payments it received were passed directly to a hedge fund that sponsored ATD’s early trading.

8. In many uses, but not here, 'alpha' is a firm's (or trader's) performance relative to that of the overall market in which it is operating.

References

- Angel, J.J., Harris, L.E. and Spatt, C.S. (2013) Equity trading in the 21st Century: An update. Available at: <<http://www.knight.com/newsroom/pdfs/researchCommentary06272013.pdf>>. Accessed 21 January 2014.
- Arjaliès, D.L., Grant, P., Hardie, I., MacKenzie, D. and Svetlova, E. (2017) *Chains of Finance: How Investment Management is Shaped*. Oxford: Oxford University Press.
- Barclays (2014) Supreme Court of the State of New York Index No. 451391/2014: Barclays' memorandum of law in support of its motion to dismiss the complaint. Available at: <<http://www.barclays.com>>. Accessed 26 August 2014.
- Bénatouïl, T. (1999) A tale of two sociologies: The critical and the pragmatic stance in contemporary French sociology. *European Journal of Social Theory*, 2(3): 379-96.
- Benquet, M. (2018) Fixer le prix des entreprises: Pour une ethno-comptabilité de l'activité des fonds d'investissement. *Sociétés Contemporaines*, 110(2): 89-117.
- Berkowitz, S.A., Logue, D.E. and Noser, E.A. (1988) The total cost of transactions on the NYSE. *Journal of Finance*, 43(1): 97-112.
- Blume, M.E. (1993) Soft dollars and the brokerage industry. *Financial Analysts Journal*, 49(2): 36-44.
- Borch, C. (2016) High-frequency trading, algorithmic finance and the flash crash: Reflections on eventalization. *Economy and Society*, 45(3-4): 350-78.
- Borch, C. and Lange, A.C. (2017) High-frequency trader subjectivity: Emotional attachment and discipline in an era of algorithms. *Socio-Economic Review*, 15(2): 283-306.
- Bourdieu, P. (1997) Le champ économique. *Actes de la Recherche en Sciences Sociales*, 119(Septembre): 48-66.
- Bourdieu, P. (2004) *Science of Science and Reflexivity*. Cambridge: Polity.
- Bourgeron, T. (Forthcoming) Constructing legitimacy: An ethnography of the struggle for financial capital in two Paris-based private equity funds. PhD dissertation, University of Edinburgh.
- Callon, M. (ed.) (1998) *The Laws of the Markets*. Oxford: Blackwell.
- Callon, M. (1999) Actor-network theory: The market test. In: Law, J. and Hassard, J. (eds.) *Actor Network Theory and After*. Oxford: Blackwell, 181-95.
- Callon, M. (2007) What does it mean to say that economics is performative? In: MacKenzie, D., Muniesa, F. and Siu, L. (eds.) *Do Economists Make Markets? On the Performativity of Economics*. Princeton, NJ: Princeton University Press, 311-57.
- Callon, M. (2017) *L'emprise des marchés: Comprendre leur fonctionnement pour pouvoir les changer*. Paris: La Découverte.
- Callon, M. and Muniesa, F. (2005) Economic markets as calculative collective devices. *Organization Studies*, 26(8): 1229-50.
- Chapman, P. (2012) Barclays polices dark pool. *Traders Magazine Online News*, 25 April. Available at: <<http://www.tradersmagazine.com>>. Accessed 25 April 2016.
- Christie, W.G. and Schultz, P.H. (1994) Why do NASDAQ market makers avoid odd-eighth quotes? *Journal of Finance*, 49(5): 1813-40.
- Coombs, N. (2016) What is an algorithm? Financial regulation in the era of high-frequency trading. *Economy and Society*, 45(2): 278-302.
- D'Antona Jr, J. (2014) Top 2014 trends: FINRA requires ATS to report trade data. *Traders Magazine Online News*, 24 December. Available at: <<http://www.tradersmagazine.com>>. Accessed 24 December 2014.

- Economides, N. and Schwartz, R.A. (1994) Making the trade: Equity trading practices and market structure. Available at: <<http://www.stern.nyu.edu/networks/making.html>>. Accessed 29 April 2015.
- Fligstein, N. (1996) Markets as politics: A political-cultural approach to market institutions. *American Sociological Review*, 61(4): 656-73.
- Fligstein, N. (2001) *The Architecture of Markets*. Princeton, NJ: Princeton University Press.
- Fligstein, N. and Dauter, L. (2007) The sociology of markets. *Annual Review of Sociology*, 33: 105-28.
- Fligstein, N. and McAdam, D. (2012) *A Theory of Fields*. Oxford: Oxford University Press.
- Godechot, O. (2000) Le bazar de la rationalité: Vers une sociologie des formes concrètes de raisonnement. *Politix*, 4/52: 17-56.
- Godechot, O. (2007) *Working rich: Salaires, bonus et appropriation du profit dans l'industrie financière*. Paris: La Découverte.
- Godechot, O. (2013) Financiarisation et fractures socio-spatiales. *L'Année sociologique*, 63(1): 17-50.
- Instinet (1989) The Crossing Network User Manual. Interviewee's private papers.
- Keim, D.B. and Madhavan, A. (1998) The cost of institutional equity trades. *Financial Analysts Journal*, 54(4): 50-69.
- Kluttz, D.N. and Fligstein, N. (2016) Varieties of sociological field theory. In: Abrutyn, S. (ed.) *Handbook of Contemporary Sociological Theory*. Basel: Springer, 185-204.
- Lange, A.C. (2016) Organizational ignorance: An ethnographic study of high-frequency trading. *Economy and Society*, 45(2): 230-50.
- Latour, B. (2005) *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.
- MacKenzie, D. (2015) Dark markets. *London Review of Books*, 37/11(4 June): 29-32.
- MacKenzie, D. (2018) Material signals: A historical sociology of high-frequency trading. *American Journal of Sociology*, 123(6): 1635-83.
- MacKenzie, M. and Thomas, H. (2009) SEC Looks to get to the bottom of 'dark pools'. *Financial Times*, 28 October: 35.
- Mirowski, P. and Nik-Khah, E. (2007) Markets made flesh: Performativity, and a problem in science studies, augmented with consideration of the FCC auctions. In: MacKenzie, D., Muniesa, F. and Siu, L. (eds.) *Do Economists Make Markets? On the Performativity of Economics*. Princeton, NJ: Princeton University Press, 190-224.
- Mol, A. (2002) *The Body Multiple: Ontology in Medical Practice*. Durham, NC: Duke University Press.
- Muniesa, F. (2003) Des marchés comme algorithmes: Sociologie de la cotation électronique à la Bourse de Paris. PhD dissertation, École Nationale Supérieure des Mines.
- Muniesa, F. (2007) Market technologies and the pragmatics of prices. *Economy and Society*, 36(3): 377-95.
- Muniesa, F. (2011) Is a stock exchange a computer solution? Explicitness, algorithms and the Arizona Stock Exchange. *International Journal of Actor-Network Theory and Technological Innovation*, 3(1): 1-15.
- Muniesa, F. (2014) *The Provoked Economy: Economic Reality and the Performative Turn*. London: Routledge.
- Muniesa, F., Millo, Y. and Callon M. (2007) An introduction to market devices. In: Callon, M., Millo, Y. and Muniesa, F. (eds.) *Market Devices*. Oxford: Blackwell, 1-12.
- Pardo-Guerra, J.P. (2010) Creating flows of interpersonal bits: The automation of the London Stock Exchange, c. 1955-90. *Economy and Society*, 39(1): 84-109.
- Philippon, T. (2015) Has the US finance industry become less efficient? On the theory and measurement of financial intermediation. *American Economic Review*, 105(4): 1408-38.

- Schinkel, W. (2007) Sociological discourse of the relational: The cases of Bourdieu and Latour. *Sociological Review*, 55(4): 707-29.
- Schneiderman, E.T. (2014) The people of the state of New York against Barclays Capital, Inc, and Barclays PLC: Summons. Available at: <<http://www.americanlawyer.com>>. Accessed 27 August 2014.
- Schwartz, R.A. and Steil, B. (2002) Controlling institutional trading costs. *Journal of Portfolio Management*, 28(3): 39-49.
- Seyfert, R. (2016) Bugs, predations or manipulations? Incompatible epistemic regimes of high-frequency trading. *Economy and Society*, 45(2): 251-77.
- Smith, R. (1984) Fee war: Pension funds feud with money managers over brokers' rebates. *Wall Street Journal*, 4 October: 1.
- Useem, M. (1996) *Investor Capitalism: How Money Managers are Changing the Face of Corporate America*. New York, NY: BasicBooks.
- Whitcomb, D.K. (1989) Letter to ATD shareholders. 11 November. Interviewee's private papers.